NCEES
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NCEES Principles and Practice of Engineering (PE)
CHEMICAL CBT Exam Specifications

Effective beginning January 1, 2020

- The PE Chemical exam is computer-based. It is closed book with an electronic reference.
- Examinees have 9 hours to complete the exam, which contains 80 questions. The 9-hour time includes a tutorial and an optional scheduled break. Examinees work all questions.
- The exam uses both the International System of units (SI) and the U.S. Customary System (USCS).
- The exam is developed with questions that require a variety of approaches and methodologies, including design, analysis, and application.
- The knowledge areas specified as examples of kinds of knowledge are not exclusive or exhaustive categories.

	Number of Questions
1. Mass/Energy Balances	**12–18**
A. Mass Balances	6–9
1. Mass balances with no reaction (e.g., density, composition, purge, bypass, recycle)	
2. Mass balances with reaction (e.g., stoichiometry, combustion, incomplete reactions, excess reactant, purge, bypass, recycle)	
B. Energy Balances	6–9
1. Energy balances with no reaction (e.g., sensible heat, latent heat, heat of solution)	
2. Energy balances with reaction (e.g., heat of reaction/combustion and combination with sensible heat, latent heat)	
2. Thermodynamics	**11–17**
A. Basic Thermodynamics	4–6
1. State functions (e.g., ideal gas law, nonideal gas, equations of state, compressibility)	
2. First and second laws of thermodynamics (e.g., enthalpy, entropy, work, free energy, heat capacity)	
3. Power cycles (e.g., refrigeration, engines, turbines, compressors, heat recovery)	
B. Chemical Equilibria	3–5
1. Reaction equilibria (e.g., equilibrium composition, reversible/irreversible)	
2. Temperature and pressure dependence (e.g., Le Chatelier Principle)	

	Number of Questions
C. Phase Equilibria	4–6
1. Ideal systems (e.g., Henry's Law, Raoult's Law, vapor pressure, Clausius-Clapeyron equation)	
2. Nonideal systems (e.g., activity coefficients, fugacity coefficients, azeotropes, immiscible/partially miscible phases)	
3. Phase equilibrium applications (e.g., bubble point, dew point, flash, solubility, critical states)	
3. Heat Transfer	**9–14**
A. Fundamentals	5–8
1. Heat transfer with no phase change (e.g., conduction, convection, radiation, mixed modes)	
2. Heat transfer with phase change (e.g., vaporization, evaporation, condensation, sublimation)	
B. Applications	4–6
1. Heat exchange equipment design (e.g., heat-transfer coefficients, fouling factors, LMTD, F-factor, equipment selection, insulation)	
2. Heat exchange equipment analysis (e.g., pressure drop, fouling effects, performance evaluation/NTU)	
4. Chemical Reaction Engineering	**6–10**
A. Fundamentals	3–5
1. Rate equation (e.g., rate constant, order of reaction, temperature/concentration/pressure dependence, Arrhenius equation)	
2. Yield and selectivity	
B. Applications	3–5
1. Conversion in reactors (e.g., batch reactor, PFR, CSTR, catalytic reactors, reactors in series or parallel, recycle)	
2. Heat effects in reactors (e.g., endothermic, exothermic, adiabatic)	
5. Fluids	**10–16**
A. Fundamentals	5–8
1. Mechanical-energy balance (e.g., Bernoulli equation, viscosity, Reynolds number)	
2. Incompressible flow (e.g., piping systems, porous media)	
3. Compressible flow (e.g., piping systems, sonic velocity, choked flow)	
B. Applications	5–8
1. Pumps, compressors, turbines, fans, and blowers	
2. Mixing	
3. Flow measurement	

		Number of Questions
6.	**Mass Transfer**	**7–11**
A.	Fundamentals	3–5
1.	Modes of mass transfer (e.g., diffusion, convection, mass-transfer coefficients)	
2.	Staged separations (e.g., theoretical stages, reflux rates, feed location, minimum reflux, minimum stages)	
B.	Applications	4–6
1.	Distillation (e.g., batch or continuous, trayed or packed, capacity/efficiency)	
2.	Gas-liquid operations (e.g., absorption, stripping, scrubbing)	
3.	Other separations (e.g., liquid-liquid, liquid-solid, gas-solid, extraction, drying, adsorption, filtration, membrane separations, crystallization)	
7.	**Plant Design and Operation**	**15–23**
A.	Safety, Health, and Environment	4–6
1.	Hazards identification and management (e.g., chemical and reactivity hazards, process hazard analysis, independent protection layers, Safety Data Sheets, exposure limits and control)	
2.	Protective systems (e.g., pressure relief, inerting, discharge location, secondary containment)	
3.	Environment (e.g., emissions evaluation, mitigation, remediation)	
B.	Design	7–11
1.	Process design (e.g., scale-up, process or product development, process flow diagrams, P&IDs, specifications, layout and siting considerations, economics)	
2.	Materials of construction (e.g., material properties and selection, corrosion)	
3.	Process equipment design (e.g., equipment selection, optimization, sizing)	
4.	Instrumentation and process control (e.g., sensors, controller actions, control valve sizing, alarms, safety instrumented systems)	
C.	Operation and Maintenance	4–6
1.	Operation (e.g., procedures, startup/shutdown)	
2.	Process equipment and reliability (e.g., testing, maintenance, mechanical integrity, failure mechanisms)	
3.	Process improvement and troubleshooting (e.g., debottlenecking, optimization)	